Selection studies for prompt $D \rightarrow h^+ h'^-$ events

Marco Gersabeck, Vava Gligorov, Eduardo Rodrigues

University of Glasgow

Flavour WG,
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Selection studies for prompt $D \rightarrow h^+ h'^-$ events

- Motivation
- Selection studies
- Conclusion
Physics opportunities

- CP violation in decays of $D \rightarrow KK/\pi\pi$
- D-Mixing using DCS $D \rightarrow K^{+}\pi^{-}$
- (CP violation in) D-mixing via lifetime ratio
- D lifetime itself

At Glasgow focus on lifetime measurements
Complementery to Oxford activities
Starting points

- Selection for $B_{(s)} \rightarrow h^+ h'^- \text{ events}$
- Selection $D^* \rightarrow D(hh)\pi \text{ events presented by Philip}$
- Aim on selection for prompt $D \rightarrow h^+ h'^- \text{ events as a starting point}$
  $\Rightarrow$ can also select $D$ not from $D^*$
  $\Rightarrow$ can add $D^*$ specific part if tagging is required
- Here: study only $D^0 \rightarrow K^- \pi^+ \text{ events}$
The selection

Start with Philip’s generic $D \rightarrow h^+ h^-$ part

- $p_T(D^0) > 1500$
- $\chi^2(D^0\text{ vertex}) < 10$
- $FD/\text{FDERR}(D^0) > 4$
- $p(h) > 5000$
- $p_T(h) > 500$
- $\text{PIDK}(K) > 8$
- $\text{PIDK}(\pi) < -8$

Additional cuts

- $\cos(\theta) > 0.99993$
- $\text{IP/IPERR}(D^0) < 3$
- $\text{IP/IPERR}(h) > 4$

Not yet applied

- Vertex isolation cut
Armenteros-Podolanski?

A possible additional cut

- Armenteros-Podolanski:
  \[ p_T^a = \sqrt{-M^2 x^a + (M^2 + m^2 - m^b) x^a - m^2} \]
  \[ x^a = p_L^a / (p_L^a + p_L^b) \]

- Does it really help?
Armenteros-Podolanski II

Does it really help?

No, cut implicitly done via tight mass cut.
In return, applying AP means rejecting sidebands needed for lifetime fit!

Marco Gersabeck

D $\rightarrow hh$ Selection
Where does this get us

- Run on L0-stripped minimum bias
- Used 1’758’242 events
- Evaluate numbers in tight mass window (±15 MeV)
- Selected candidates: 87
- Breakdown in background categories:

<table>
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<th>category</th>
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<td>candidates</td>
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<td>1</td>
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- $S/B = 86$
- Expected rate after L0 + selection (assuming 1MHz L0):
  - signal: 48.9 Hz, total: 49.5 Hz
- Plus factor 2 from anti-$D$
The mass peak

- Full selection with $\pm 250$ MeV mass window

- Total yield in wide mass window: 199 candidates

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<td>52</td>
<td>16</td>
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ToDo List

- Implement LoKi-based DV selection
- Check performance on other $D \rightarrow h^+ h'^- $ channels
- Run on all available data
- Check promptness
- Optimise cuts
- Use selected $D \rightarrow h^+ h'^- $ data in lifetime studies
Conclusion

- Selection for prompt \( D \rightarrow h^+ h'^- \) complete
- Expected signal rate for \( D^0 \rightarrow K^- \pi^+ \approx 50 \) Hz
- Plan first lifetime measurement in \( D \rightarrow h^+ h'^- \)
Numbers for 5 pb$^{-1}$:

- $D \rightarrow K^-\pi^+$ 125k, (BR 3.80%)
- $D \rightarrow K^-K^+$ 13k, (BR 0.38%)
- $D \rightarrow \pi^-\pi^+$ 5k, (BR 0.14%)
- $D \rightarrow K^+\pi^-$ 0.5k, (BR 0.01%)

Expect up to 0.5k events in any given $B \rightarrow Dh$ channel

Critically depends on VELO